# **Insolation and Temperature**

## **Chapter 4**

# **Energy, Heat and Temperature**

## Difference between **Heat** and **Temperature**

### **Energy**

#### **Kinetic energy** -- **internal energy of molecule movement**

### **Temperature**

#### **Temperature** – the average **kinetic energy** of the molecules in a substance

### **Heat** – **energy that transfers from on object to another because of the difference in temperature**.

## How to **measure temperature**

### **Thermometers**—measures temperature

#### **Fahrenheit scale**

##### Used only in the US

##### Water Freezes at 32o

##### Water Boils at 212o

#### **Celsius scale**

##### Used throughout the rest of the world

##### Water freezes a 0o

##### Water boils at 100o

#### **Kelvin scale**

##### Used in the scientific world

# Solar Energy

## **Electromagnetic radiation**

### **Energy from the Sun**

## **Electromagnetic spectrum**

### **Different wavelengths of light**

#### **Visible light – 0.4 -0.7**

##### Violet, Blue, Green, Yellow, Orange, Red

#### **Ultra-Violet Radiation**

##### **Shorter waves than visible light** – 0.1- 0.4

##### **Mostly absorbed by the Ozone Layer**

#### **Infrared Radiation**

##### **Longer waves than visible light – 0.7 – 1.0**

#### **From Near Infrared to Thermal infrared**

# Solar Energy

## **Radiation from Earth–Terrestrial Radiation**

### Long wave Radiation – about 4 micrometers

## **Solar Radiation is at a constant level**

### When it hits the Earth’s atmosphere,

#### **Some reflected back**

#### **The rest passes through the Atmosphere**

#### **to be transformed into different energies**

# **Basic Heating & Cooling Processes in the Atmosphere**

## **Radiation or Emission**

### The process by which **electromagnetic energy is emitted from an object**

#### **The hotter the object the more radiation it emits**

# **Basic Heating and Cooling Processing in the Atmosphere**

## **Absorption**

### The **assimilation of electromagnetic waves by striking an object**

#### **Different objects have different absorption abilities**

## **Reflection**

### The **ability of an object to repel electromagnetic waves without altering either the object or the waves**

## **Transmission**

### Process whereby **electromagnetic waves pass through a medium like class or clear water**

### **The Greenhouse Effect**– **incoming short wave radiation enters an area, but the reflective longer waves cannot escape, causing the area to heat**

## **Scattering**

### The **act of deflecting or redirecting light waves** with gas molecules and particulate matter in the air

### **Rayleigh Scattering** – when the **shortest wavelengths are scattered (violet and blue) – causes the “blue sky”**

### **Sunset or Sunrise**– **all the blue waves scattered as the energy passes through a longer atmosphere (larger angle) red, orange, and yellow left.**

## **Conduction**

### **Movement of heat energy from one molecule to another without changes to their relative positions**

## **Convection**

### **Heat is transferred from one point to another by the predominately vertical circulation of fluid, such as water or air.**

## **Advection**

### **When the dominate direction of heat transfer is moving fluid horizontally**

# Basic Heating and Cooling Processes in the Atmosphere

## **Adiabatic Cooling and Warming**

### Whenever air **ascends or descends, the temperature changes**

#### **Expansion: Adiabatic Cooling**

##### **As air rises the air cools**, as the molecules spread out loosing heat

#### **Compression: Adiabatic Warming**

##### **As air descends it is compressed**, the molecules collide and create heat

### **Latent Heat**

#### **Storage or release of energy**

##### **Evaporation-** **liquid water changes to gases, energy is released, cooling happens**

##### **Condensation**- **gaseous water vapor turns to liquid energy is stored, heating happens**

# **Heating of the Atmosphere**

## **Global Energy Budget**

### **100 units of Solar Radiation hit the atmosphere**.

#### Some absorbed

#### Some reflected

#### Some radiated

### **Total units radiated out 100 units**

### **Albedo**

#### **The reflective value of an object**

##### The higher the **Albedo value** the more radiation the object reflects

## The **atmosphere is heated by *Earth radiation*** rather than the sun radiation

# **Variations in Heating by Latitude & Season**

## **Angle of Incidence**

### **Higher the angle (90%)**

#### The smaller the area of Earth receiving high energy (**warmer**)

### **Lower the angle (10%)**

#### The larger the area of Earth receiving high energy (**cooler**)

## **Atmospheric Obstruction**

### **The amount of atmosphere the energy passes through and the transparency of the atmosphere affects the energy received**

## **Day Length**

### **Duration of sunlight affects the energy received**

## **Latitudinal Radiational Balance**

### **Low Latitudes – more solar energy**

### **High Latitudes – less solar energy**

### **Balanced across the atmosphere**

# **Land & Water Contrasts**

## **Heating**

### **Specific Heat**

#### Amount of energy required to raise 1 gram of substance by 1 degree Celsius

### **Transmission**

#### Water is a better transmitter of sunrays than land

### **Mobility**

#### Water is high mobile and moves heat broadly and deeply

### **Evaporative cooling**

#### Evaporative cooling is more prevalent over the water than over land. Latent heat is needed for this evaporation keeping the surface of water cooler.

## **Cooling**

### Land cools more rapidly than water

## **Implications**

### ***Hottest and coldest areas of the earth are inland***

# **Mechanisms of Heat Transfer around the Continents**

## **Atmospheric Circulation**

### **Ocean Currents**

#### Close relation of the atmospheric circulation with ocean currents

#### Heat transfer by this circulation

## **Basic Patterns**

### North Pacific, South Pacific, North Atlantic, South Atlantic, and South Indian

### Continuous flow- West Wind Drift

## **Current Temperatures**

### **Low Latitude currents – warm**

### **Poleward – moving currents on western sides – warm**

### **Northern Components – warm north and east**

### **Southern Components – combined with the West Wind – usually cool**

### **Equator-ward moving currents on the eastern side – cool**

# **Vertical Temperature Patterns**

## **Environmental Lapse Rate**

### Observed trend of vertical temperature change in the atmosphere

## **Average Lapse Rate** normal vertical temperature gradient of the troposphere

### **The average rate of temperature change is about 3.6 o over 1000 feet**.

## **Temperature Inversions**

### **Temperature increases with altitude**

#### **Surface inversions**

##### **Radiation inversion** – rapid radiation cooling – long cold winter nights

##### **Advection inversion** – horizontal inflow of cold air– maritime air blowing in from the sea

##### **Cold-Air-Drainage inversion** – cold air sliding down a slope into a valley

#### **Upper Air Inversion**

##### **Subsidence Inversion --**Result of air sinking from above

# **Global Temperature Patterns**

## **Patterns of temperature** controlled by four factors– shown on maps with **Isotherms**

### **Altitude**

### **Latitude**

### **Land-Water Contrasts**

### **Ocean Currents**

## **Altitude**

### Complexity of the land, makes temperature depiction tricky

### Use of the average lapse rate reduces the temperature at what it would be at sea level

## **Latitude**

### East-west trend of temperatures roughly along parallels

## **Land-Water Contrasts**

### Differences apparent on a map

### Summer and winter extremes apparent over continents more than over the water

### In **southern latitudes, the isotherms are more regular because of the presence of more water**

## **Ocean Currents**

### Obvious bends in the isotherms are along the coastal waters

### These follow the ocean currents, - warmer seasons over the warmer currents, cooler seasons over the cooler current

## **Seasonal Patterns**

### Latitudinal shift of the isotherms

### **Changes in the seasons**

#### Over **tropical areas little changes**

#### Over the **mid latitudes, basic seasons**

#### Over the **higher latitudes, seasons are cool, even in summer months**

## **Average Temperature Range**

### The **average temperature between the warmest and coldest months**

# **Global Warming and Greenhouse Effect**

## What do you think about this highly controversial happening